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THE UNIVERSITY OF TORONTO MEDICAL JOURNAL

(An Undergraduate Publication)

This journal is published seven times a year, November to May, by the Medical Society of the University of Toronto, to serve as a medium for student expression and to bring to the student recent articles of scientific interest.

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Volume IX

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Number 1

EDITORIAL

It is now eight years since the University of Toronto Medical Journal was established. The Editors of Volume 1, No. 1, with optimistic prognostication, wrote: "We mark an epoch in the history of the undergraduate body of the Faculty of Medicine." We believe they did.

The lagging editorial cerebrum must always be stimulated by a perusal of the early columns of the Journal. The first few volumes were quite ambitious, some issues running to over fifty pages. The standard set was, from the very start, a high one, but most of the articles were written by staff members of the Faculty of Medicine. Gradually, slowly, the proportion of articles by undergraduates has risen in the years

intervening from about 20% to over 60% in the 1930-31 volume.

This is not an appeal for assistance in filling these pages. Space that is not taken by student articles can still be used, and well used, by Faculty members. But the function of this Journal is essentially the expression of *student* thought. This can only be supplied by the student himself. No amount of illuminating and helpful writing by obliging Faculty members and others not of the student body, can help us to fulfil this function. Nor can it help the student to attain a certain proficiency in a line that may — and for some undoubtedly will — occupy an important place in his scheme of things — that is, contribution to

medical literature. As a member of the staff recently remarked: "It is the only ethical method of medical advertising."

Avail yourself of an opportunity almost unique in medical schools of this continent. Submit to the editors, if, and when you feel inclined, articles bearing directly, indirectly, or not at all, on the study of medicine. And the editorial staff will carefully and thoroughly consider them, willing at all times to discuss a choice of subject, to offer whatever advice they can, on any matter pertinent to contributions.

It has ever been an editorial dream (never satisfactorily realized) to publish in the Journal, material of interest to the first, second and third years, and the B. and M.Sc. course. The realization of this dream seems to lie in the awakening of sufficient interest among the members of these years to call forth articles from them, not requiring specific knowledge which they have not yet had the opportunity of acquiring. In an effort to do this, we have appointed editorial representatives from the first three years to the staff of the Journal.

The few papers written in the past issues by junior students have been among the best and most interesting. An article in the 1923 Volume, by a member of the second year, on "The Development of Anatomical Science," made the most pleasant reading of all in an issue full of the cream of medical papers.

This volume of the Journal is introduced with the hope of previous years' success — and something more. From the undergraduate interested in his chosen profession, the editors urge close co-operation. From the members of the staff, so generous and helpful in the past, we would beg even more of the wisdom of their experience. And we invite any man who has ideas to come forward and express himself.

AND NOW—3T7.

No first issue of any university publication could be complete without the time-honored word of welcome and

words of advice, descending in benign condescension on youthful freshman heads. Methinks we hear editors from the beginnings of things murmuring, "work comes first and play afterwards, but the happy medium" and perhaps quoting from Flanders Fields . . .

But is there aught else to say? The student who is about to graduate looks back on the six, seven, or eight years it has taken,—and wonders how he ever got thus far . . . and tries to remember the name of that girl he took to the Masquerade in his second year . . . and asks himself whether he can remember one thing from his first year except his initiation and that liquid air is great stuff to play with . . . the smell of the anatomy lab and frog-jumping in physiology seem to have been in more recent eras . . . wonder if they still cook up results in Biochemistry? . . . He says he would know his anatomy better if he had to do it over again,—but we doubt it.

Enough: we grow philosophical.

Hail to the first year,—may they enjoy it as much as we !

IN THIS ISSUE.

Sir Robert Falconer, who is retiring from the presidency of the University of Toronto at the end of this academic year, has gained the admiration and respect of all students who have passed through 'Varsity during the past twenty-five years. He has shown a great interest in the Medical Faculty and undergraduates have felt, as he assisted at the Balfour Lecture or other medical function, that here was a layman who understood just how very important was 'The Profession.

Characteristically, the first article to reach the Editor was the President's response on "The Last Quarter Century in the Faculty of Medicine." We know that all, graduate and undergraduate, will read it with great interest—and regret, with the Editors, that it is to be only a quarter of a century.

The Last Quarter of a Century of the Faculty of Medicine.

By SIR R. A. FALCONER.

As I look back now over the twenty-four years during which I have been connected with the administration of the University of Toronto, not the least pleasant of my memories are those that come to me from the staff and students of the Faculty of Medicine. Moreover not the least satisfaction which I have arises from my association with that Faculty during one of the most significant eras of its history. It is characteristic of human nature to magnify our attainments and to minimize our faults. We must, therefore, not take at their face value all the soothing eulogies which the modest among us pass on to one another in private, nor all the claims which the more self-confident are not afraid to assert in public. But the fact is that for a number of years outside authorities and visitors from afar have passed such encomiums upon the work of our Faculty of Medicine as have, in so far as I can judge, banished most of any "inferiority complex" which existed (if any did really exist). The spirit of being well-born professionally has spread through our graduates, and when they enter into competition with graduates of other universities on the Prairies or in British Columbia, they are quite as ready as others to sing the praises of their *Alma Mater*.

I should not venture to compare the men of the present with the men of the past. Probably in each decade the average is much the same in quality, coming as they do from a constituency which has remained so uniform in its character. But there has been a gradual improvement in the standards of professional training. For my own private use I could pick out the names of a few men who have given the impulse and direction to the progress of this faculty during the last quarter of a century. But quite as great factors as a few outstanding individualities, have been the better co-

ordination of the work of average high-class persons and the introduction of new methods in teaching and research. In preceding decades the personal qualities were there, but recently better results have been achieved through the introduction of newer methods which have been coming into vogue everywhere. A day of somewhat dissipated energies has given way to a present in which gifts and abilities are concentrated for the advantage of the student.

As I have already remarked, it would be invidious to mention those professors who more than others have been in the van of this progress, especially as some of the most influential are still alive. But I cannot forbear to call up the memory of two Deans who have passed away—Dr. R. A. Reeve, who resigned his office in 1908, and Dr. C. K. Clarke, who retired from the deanship in 1920. Of these men I think primarily because of their character. They were both gentlemen of the finest quality and worthy to stand before the undergraduates as types of man whom the young doctor should admire. Dr. Reeve was widely known on this Continent and in Britain; always carefully but not ostentatiously dressed, cultivated both in speech and bearing, he never failed the University. No more devoted son of his *Alma Mater* could be found, and no one sought more disinterestedly to promote the welfare of the undergraduate. In most unexpected ways of his own he would show them personal kindness, and he quietly set before them the ethics of the profession for which they were preparing. I well remember the disappointment I felt when he told me that for private reasons he intended to send me his resignation from his deanship. At that time, perhaps more than ever since, there were difficulties in the faculty for the solution of which I greatly needed his help. But after much deliberation a

new dean was appointed, Dr. C. K. Clarke, then professor of psychiatry and superintendent of the Queen Street Hospital. He had done invaluable work for the Government in investigating in Europe and elsewhere, the most recent methods for treating mental diseases, and for a time there was strong hope that the Hon. W. J. Hanna, who was deeply interested in social welfare, would be able to get a psychiatric hospital established; but that day was yet to come. It will be admitted that few, if any, men in this country have made a better reputation than Dr. Clarke as an alienist. He was an excellent judge of men for the same reason that he was a first-class alienist. He was an expert also in abnormal psychology, but held his way carefully, and never lost his head in the mazes of that department of study, which perhaps more than any other is cluttered with discarded theories and pitfalls. Men were sometimes irritated by his steady look and sudden outbreak of humour, for they felt that he did not take them as seriously as they deserved. But he treasured no resentments and returned good for evil. Nowhere was he more at home than among undergraduates. Instinctively they knew that in him was a man whom they could trust, to whom they could get near, and on whom they could not impose; partly because he was himself so free from vanities and from self-seeking. He played a violin in their orchestra, moderated excitements which might have led to inter-faculty troubles, gave help to the depressed, and was deeply affected when perchance he discovered that some student had brought disgrace on himself and his friends.

In turning briefly to the outward signs of development in the faculty of medicine, reference must be made both to the laboratory accommodation and equipment and to the hospital opportunities which attract the favourable comment of visitors. The erection of the Toronto General Hospital in 1913, and its extension during the past three years, under the leadership of generous trustees, have been of immense benefit

to the University, which has in it remarkable privileges. Nor should I fail to mention the great advantages we enjoy in the Sick Children's Hospital, St. Michael's and the Western, all of which have in recent years been enlarged and better furnished forth.

The notable events during the past quarter of a century, taking them chronologically, have been Colonel A. E. Gooderham's gift of a farm of seventy-five acres and the erection on it of the first Connaught Laboratories; the gift of \$25,000 a year for twenty years by the late Sir John Eaton and Lady Eaton, for the development of the department of clinical medicine including the diseases of children; the receipt of over one million dollars for the extension of medical education, as our share of a special gift made by Mr. John D. Rockefeller to the Medical Schools of Canada, in recognition of the work of Canadians in the war; the momentous discovery and development of Insulin; the grants by the Rockefeller Foundation of large amounts for the development of a School of Hygiene and research in Preventive Medicine. Significant additions have been made periodically to the teaching departments, the latest being this year, that of neuro-pathology as a sub-department of pathology, with the co-operation of the Government, especially in connection with the Psychiatric Hospital. So constant has this development been that it is difficult to realize the concomitant changes that have been going on in the spirit and method of teaching. To two only will I refer: the character of the curriculum, and the growth of research.

Medical education has been receiving a great deal of attention on this Continent ever since Abraham Flexner's Report was published by the Carnegie Foundation for the Advancement of Teaching; and the report of the latest Commission will probably soon be forthcoming. Our Faculty of Medicine has kept itself fully informed of these discussions. But great and beneficial as has been the influence on Canada of

such American Medical Schools as John Hopkins and Harvard, the traditions of Toronto with Great Britain have not been forgotten. The best American Schools have divided their course into two parts—a preliminary two years of a college course in Arts, or in some schools four years with a B.A. covering the scientific subjects, and a regular course of four years in a medical school, on the conclusion of which the student graduates with an M.D. degree. Our Faculty, situated as it is in a great university, has never accepted this division, nor believed that a complete course in Arts is always the best preparation for professional work in Medicine. Instead the standard of entrance to the Faculty has been raised, in accordance with the local conditions of this province, to honour matriculation, which is nearly equivalent to the work of the former first year in pass Arts in our own University or in an American college. The medical course itself was lengthened from five to six years, but was divided into two at the end of the third year; the first half scientific (to use that term generally) and the second clinical. It was believed that the University itself should arrange its own scientific preparation beginning with the standard of the sciences at honour matriculation, and give some general options, and that the second half of the course should be almost a new chapter. Into this, however, more advanced work, especially in anatomy and physiology, might be carried over and integrated with the medicine and surgery. Also, by having as it were a preliminary chapter ended, it would be possible for the few, who might be interested in going further in any of these sciences, to take an extra year and get a B.Sc. degree before resuming and completing their more professional subjects. At the time of its inception this new course was watched with interest by other universities, and favourable attention was drawn to it by the "British Medical Journal." Apart from slight modifications this course has now been in existence for ten years, and the faculty has seen no reason for

radical change. We have good reason to believe that our students, most of whom spend afterwards a year in a hospital, are able to hold their own with those from the best medical schools.

The second feature that has been assuming large importance in recent years has been the development of Medical Research. Of course Dr. Banting himself is head of such a department, but in general medicine, surgery and allied branches, and in every one of the supporting sciences, research of a high order, much of it having attracted the attention of the medical world, is being conducted in laboratories of first-class efficiency and equipment. This same spirit has gone further. Our staff realize that the progress of medical knowledge is so rapid, that it is a duty to provide, as far as possible, post-graduate work for their students who may not be within reach of the University. So Extension Courses, some of them under the direction of the Dominion Medical Council and with support of the Universities of the Dominion, have been undertaken to the great advantage of the medical profession and the public all over our country.

I can congratulate our medical undergraduates on their good fortune in taking their course at the University of Toronto in an era of great energy and efficiency. I am confident that never has a better spirit animated the faculty than that of the past decade, and our recent graduates are proving their quality by the recognition that is given them in the leading medical centres of both continents. That this is being reflected also in the improvement of the health of our communities, I have no doubt; nor can it be safely challenged that the province has been receiving an abundant return for the money that it has spent on medical education and research. It must also be remembered that no other faculty of the university has received such gifts from generous benefactors, and therefore that the return to the province for its financial support has been multiplied.

Drug Addiction.

By J. K. W. FERGUSON, M.A., '32.

Many countries, alarmed by the growing use of habit-forming drugs, have been trying to control their sale and distribution by stringent laws. Much credit for encouraging legislative interest in the problem is due to League of Nations, which is still active in prodding the national conscience of those countries who yet are loth to disturb so profitable a traffic. At the present time, in Canada, the trade in narcotics is regulated by the Opium and Narcotic Drug Act, 1929. Its schedule includes the following drugs:—

“Cocaine, its derivatives, or any salts or compounds thereof.

Morphene, its derivatives, or any salts or compounds thereof, but not including apomorphine.

Heroin, or any salts or compounds thereof.

Opium, or its preparations, or any opium alkaloids or their derivatives, but not including codeine or apomorphine.

Eucaine, or any salts or compounds thereof.

Cannabis Sativa and its preparations.

Coca Leaf.

Crude Cocaine.

Ecgonine.

Di-hydro-oxycodine.

Di-hydro-codeine.”

Many other drugs may be habit-forming, but their devotees being few, present no great social problem. (Alcohol, however, hardly fits that description, and is often habit-forming in the worst sense. But then alcohol has been the object of so much separate legislative attention that surely it deserves a separate article). The last three names on the proscribed list are quite unfamiliar to doctors, and do not appear in any ordinary *Materia Medica*. They may be disposed of with a few words. Ecgonine is related to

cocaine; to be exact, cocaine is derived chemically from ecgonine, and probably for that reason alone it was included in the schedule. Di-hydro oxycodine and Di-hydro-codeine are compounds intermediate between codeine and morphine, both in chemical constitution and pharmacological action.

Against opium smoking, the Act seems to aim its most drastic measures, perhaps for two reasons. In the first place, the public horror of opium dens, with all their associations, is very great; and in the second place, none of the appliances or materials for opium smoking has any valuable use. As a matter of interest, however, it might be well to point out that opium is far from being the most pernicious drug on the list. It is well known that one may indulge every Saturday night, or even daily, in opium smoking, and still not be an addict; just as one may habitually drink beer with every meal and still not be a dipsomaniac. It is true, however, that real addiction to opium does develop in some people, perhaps because of too generous or too frequent indulgence.

At this point it must be obvious that addiction and habituation, though often used almost synonymously, might well be differentiated, at least in scientific discussion. A difference of degree is established when we say that addiction is a state developed by the repeated administration of a drug till its influence becomes necessary, in the sense that when the effect of the drug wears off, mental and physical disturbances associated with great suffering, are induced. On the other hand, in habituation, the drug is desired frequently or regularly, but no ill effects follow the stopping of its use.

Before leaving the topics connected with the Opium and Narcotic Drug Act, it might be useful to summarize

the provisions which are of most interest to doctors.

(1). Orders for the drugs specified in the Act, must be in writing, dated and signed by the, " . . . duly authorized and practising physician . . ."

(2). This formality is not necessary when the preparation ordered does not " . . . contain more than two grains of opium or more than one-fourth of a grain of morphine or any salt or derivative of them, in one fluid ounce . . . or . . . one avoirdupois ounce . . . (provided) . . . any such preparation contains active medicinal drugs other than narcotic . . ."

No such liberty is allowed with any preparation of cocaine.

(3). A doctor must not, " . . . furnish or prescribe any drug to an habitual user for self-administration, unless such habitual user be suffering from a diseased condition caused otherwise than by excessive use of any drug."

In Canada and the United States, heroin (diacetylmorphine) is by far the most popular drug of addiction; next comes morphine; and, third, cocaine. Addicts to any other drugs than these three are very few. The devotees to heroin and morphine; constituting the great majority of all addicts, are met in every walk of life, but they may be divided, without too much artificiality, into three classes. The first class includes chronic invalids and the slowly dying. In these cases the law allows the doctor ample scope to use his judgment about prescribing drugs. He must be careful, however, for if in any instance a legal inquiry were to follow, the doctor would be required to prove that the narcotic was prescribed as a part of his treatment of the patient, for " . . . a diseased condition caused otherwise than by excessive use of any drug." Should the patient recover from his "Diseased condition," the doctor may not, under any circumstances, continue to supply him with narcotic for self-administration, and the patient is left facing the unhappy alternative of get-

ting drugs from illicit sources or taking a cure. The doctor shoulders a grave responsibility — which, moreover, he cannot always avoid — when he prescribes repeated doses of narcotic for a patient who may recover from his prolonged illness.

The second class comprises those who may be described as underworld characters (a convenient term, which implies an intimate acquaintance with the shady side of life in our large cities). Most of these people possess average intelligence, and only a small proportion of them have mental kinks or innate criminal tendencies. Association with an illicit traffic is not morally elevating, and often smooths the way to serious crime. Thus it often happens that an addict of the underworld type relies entirely on theft or fraud to support his expensive habit. When he is caught (and it is usually for theft or fraud that he is caught rather than for unlawful possession of drugs), with his jail sentence he has the advantage of a compulsory cure. We can only guess at the number who are never caught.

The third class is even harder to survey. It includes all persons who manage their lives respectably and with such discretion that their secret addiction is unknown to most of their friends. Addicts often hint that if they chose they could startle the public by disclosing many prominent professional men, business men and society women as slaves of the "Habit." Probably some truth lies behind these hints. Nearly every doctor knows at least one member of this unhappy group, and may know too the thorn in the flesh which led to his enslavement.

Medical treatment must be responsible for starting many addicts, but certainly not all. In the reformatories where addicts of the underworld type predominate, one often hears them admit freely that their habit began in a deliberate attempt to find a new thrill in life. Oddly enough, many of them seem to feel a lofty superiority to those

poor mortals who have not known the pleasures of "Junk." (In their slang drugs are "Junk"; and addicts, "Junkers.") This air of superiority, together with the fact that junk is their main topic of thought and conversation, make the addicts very dangerous inmates of our prisons. The impressionable boys of seventeen to twenty who fill our reformatories, listen with awe to the old roués, and in many cases resolve to try drugs themselves when they get the chance.

It is hard to imagine what attraction a beginner can find in morphine or heroin. Often the first dose makes him sick (of course, the same is true of smoking). If he were nervous, overworked, or suffering pain, the deadening effect which these drugs have on sensation might be very grateful. With cocaine the situation is different. Most of the people looking to drugs as a new source of enjoyment start with cocaine. It can be taken in the form of snuff, obviating the use of a hypodermic needle — always unpleasant to a beginner. In its action on the central nervous system, cocaine is not a narcotic but a stimulant. A delightful feeling of exhilaration, well being, and physical vigour is the charm of its use. Unlike morphine and heroin, cocaine taken repeatedly does not produce tolerance, that is to say, larger and larger doses are not required to produce a certain effect. Quite the opposite happens; the same dose has greater and greater effect as time goes on. Connected, probably, with this phenomenon, is the observation that even after prolonged use of cocaine, its withdrawal does not cause distress at all comparable to the distress following the withdrawal of morphine. The discomfort which is felt may be attributed to the natural exhaustion and low spirits following a period of unnatural vivacity. Cocaine, then, causes something more like an habituation than a real addiction. Cannabis Indica (often referred to in fiction as Hashish) is said to act in much the same way. The ultimate effects of either

habit are not often seen in this country. It is distinctly unusual for the cocaine habit to be kept up over a period of years. Once I had the opportunity of examining a cocaine "snuffer" who said he had indulged more or less continuously for ten years. Apart from striking changes in his nasal mucosa, he seemed to be in good health, and in possession of all his wits. It is usually stated, however, that persistence in the habit eventually causes great mental and physical deterioration. Why do most cocaine snuffers transfer their allegiance, sooner or later, to morphine and heroin? One reason is said to be that, alarmed by the increasing potency of his usual dose, the habitué casts about to find another drug to comfort his jaded spirits, or begins to take morphine with the cocaine to moderate its excitatory effect. Whatever the reason, it seems to be a fact that most people who take to drugs for the sake of enjoyment, start with cocaine and change later to morphine or heroin.

Morphine and heroin may be considered together. The latter is used by more addicts, perhaps because it is the more depressant. The cardinal sign or criterion of addiction to either of these drugs, is the onset of "Withdrawal symptoms" as the effect of the drug wears off. A normal person may be kept under the influence of morphine for weeks or even months (depending largely on the frequency of administration) before withdrawal symptoms appear; but a person who has been addicted previously requires very few doses, perhaps only two or three, to rekindle the craving — a useful point to remember. Withdrawal symptoms are no mere fancies which need only will power to suppress. External signs in the form of diarrhoea and perspiration nearly always accompany them. If these are absent the complete demoralization of the victim is sufficient evidence of his agony. To begin with, he feels an indefinite restlessness and irritability, soon followed by muscular pains and intestinal cramps. All the

symptoms mount rapidly to such a pitch that within a few hours he resembles nothing more than a wild animal in mortal terror. Sheer force alone will keep him from his drug. In some cases the most severe torture lasts only six or seven hours; in others the symptoms may be less intense but last almost a week. A good deal of discomfort persists for nearly a month, but after that nothing which may be called physical suffering remains. From then on the patient gains in weight, as a rule, and improves in general health. In this stage many resolve to go straight from now on, but the mental-fascination and the element of habit, still persist and cause backsliding in all too many instances. It seems improbable that the physical craving ever returns without indulgence in a dose or two of the drug; in other words, it is improbable that anything in the nature of mild withdrawal symptoms recur spontaneously.

Another constant feature of addiction to morphine and heroin is the development of some degree of tolerance. Larger and larger doses must be taken to produce the required effect. To keep comfortable the addict progressively increases his dose. It is not at all uncommon to meet one who takes hypodermically fifteen grains of morphine a day. Some reach the stage where they inject the drug directly into a vein to get a more powerful and immediate "Kick." These people are known in the slang as "Main-liners." Judging by the obvious pride with which they show their thrombosed veins, I would say that they must be quite the élite of the fraternity. The largest dose of heroin that can be taken intravenously by the most seasoned addict, is said to be about four grains. As his dosage increases and nears this amount it becomes an interesting speculation, whether the addict's next injection will kill him or not. If at this time he happens to be arrested, or if he has the means to go to a private sanitarium, or the will power to commit himself to a mental hospital, he

may obtain a new lease of life. Many addicts renew their lease periodically by taking cures.

Some addicts, however, are able to keep their intake at a constant, moderate level for years on end. One old doctor, sixty-eight years of age, told me that he had taken three-and-a-half grains of morphine a day for thirty-five years and never had a cure. This may be a peculiar attribute of some people, but Dr. E. S. Bishop maintains that it is largely a matter of how the drug is taken. If the time between successive doses be made as long as possible, even though the same *amount* be taken in twenty-four hours, the inhibitory effects of the drug are diminished. With care in this regard the tendency to constipation can be overcome, and with free elimination the need for increasing doses is said to disappear.

Whether or not he has to increase his dosage, the addict is not in a happy situation. Always he has the fear of being cut off from his supply. If he is a respectable and useful member of his community, the fear of exposure and disgrace haunts him. What hope is offered by the so-called cures? At present they are all extremely uncomfortable, but they do lead to freedom from the physical need of the drug. The mental dependence and the element of habit remain, however, and the chances of conquering them must be estimated. In this connection it is useful to consider addicts according to the three classes outlined earlier in the paper. In the first class, the slowly dying are not involved in the problem, and neither are the chronic invalids, as long as they are really ill; but those recovering from long and painful illnesses in which they have been kept continuously under narcotics, most decidedly are. Nevertheless, their chances for complete freedom are good, provided they have average mental and moral stamina. In many cases they stand the torture of withdrawal with great courage. They have no residual hankering after the drug. In the absence of pain, they

don't feel dependent on it; their habit was conditioned to severe pain.

As to members of the second class—the underworld characters—it would appear that one per cent. is a liberal estimate of the proportion of those cured who do not relapse. For people of this type, self-indulgence is one of the cardinal principles of life. Respectability has no attraction for them, and is out of their reach anyway. But most important of all is the fact that they have been habitually dependent on the drug to ease all their every-day pains and aches. When they feel a little out of sorts, it is the first remedy they think of. Sooner or later, in a moment of weariness or illness, they yield to temptation. The physical craving soon becomes re-established.

The members of class III., who to outward appearance live a normal life, are better off than the preceding group in only one way. Their self-respect and the opinions of their friends are powerful motives in favour of conquering the habit. For this reason they would have a better chance of getting a permanent cure if it were not for peculiar difficulties which confront them. To all appearances they are living a normal life, and they have to shoulder its responsibilities. A three months' holiday for treatment may give their finances a serious blow. The longer holiday they take the better will be their physical condition when they return, but the greater too will be their financial loss, and the accumulation of duties and worries. Then, too, the first cause of the addiction may be some physical or emotional handicap which is still with them. They go back to the old conditions of life, the strain of which has not been lessened by their holiday; small wonder that they relapse so often into the old habit? This class of addict arouses the sympathy of all who are interested in the problem. Under our strict narcotic law, they suffer out of all proportion to their apparent deserts. The only way of helping these people seems to lie in the direction of better facilities for treat-

ment, better methods of treatment, and financial aid by the government where necessary.

Every so often a new treatment or remedy for drug addiction is heralded in the newspapers. A few years ago Narcosan was the subject of front page reports. We hear little of it now. In 1929 the Mayor's Committee in New York undertook a thorough investigation of the methods of treatment in vogue. They did it in fine style. Three hundred and eighteen patients were treated. Each was subjected to a complete examination, including the whole range of laboratory and psychiatric tests, and his progress carefully recorded in detail. For a brief but full account of this interesting piece of work the reader is referred to the report of the committee, by A. Lambert.

Some of the results are quoted below.

(1). Narcosan is useless.

(2). Atropine prevents the diarrhoea but has no effect on other symptoms.

(3). Magnesium sulphate injected intramuscularly in sufficient quantities to keep the blood magnesium above 5 mg. per 100cc. greatly ameliorated the symptoms, but local disturbances at the site of injection made the method impracticable.

(4). Amytal was tried and found to produce sleep for five or six hours, but a second dose was ineffectual, or caused delirium.

Although the efforts to find a painless cure for addiction were a failure, a rational and practical routine for management and treatment was evolved. For young and robust patients they recommended that the reduction of the drug be spread out over seven days. For old and ailing ones they found it safer to let the reduction occupy fourteen days. In conclusion, they remark that the permanent results were "Unsatisfactory." !

So many painless treatments have been proclaimed to an eager world, only to wither under critical experiment, that we can hardly help being skepti-

cal of the latest, announced by Dr. G. Laughton Scott. Briefly, it is a novel way of giving the drug atropine (in the form of the Tincture of Belladonna) while the narcotic is being withdrawn. Instead of giving a constant amount of the tincture daily, the dose is increased as the patient's tolerance increases, the object being to keep the patient on the verge of a toxic state, as indicated by a rising pulse rate, flushing, and dilated pupils. In addition, Luminal is given at noon and night. Withdrawal symptoms are said to be negligible under this regime. Undoubtedly, some skill and experience would be necessary for the successful application of this method. Dr. Scott presents his subject in a very convinc-

ing, straightforward manner. His little book, "The Morphine Habit and its Painless Treatment," is well worth reading.

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Hydrocephalus.

By G. E. HOBBS, B.A., '33.

Hydrocephalus is a term loosely used to designate a condition characterized by an excess amount of watery fluid within the skull. This condition may be attended with compression of the brain, which is the usual condition, or it may be compensatory to non-development of cerebral tissue. This condition may be either internal, the common one, where the excess of fluid is within the ventricles, or external, where the excess of fluid is situated outside of the brain substance. Internal hydrocephalus is usually found bilaterally but it can be limited to one hemisphere.

Hydrocephalus is usually associated with some degree of mental deficiency, but people with a normal intelligence can be found who have a slight degree of it. Cases of hydrocephalus fall into two broad types: in the one, the mental deficiency is of minor importance for the person is acutely ill, with the body wasted, having convulsions and a severe paralysis. They may be blind or deaf. In the other type the hydrocephalus has increased slowly or undergone

spontaneous arrest, so that these come under observation as mental defectives. Their defect may vary from a mild degree to pronounced imbecility. The proportion of mental deficiency due directly to this condition is in the vicinity of 0.5%. Besides a mental deficiency secondary to this condition, it is quite possible that a person mentally defective from some other cause might develop hydrocephalus.

Etiology.

Hydrocephalus is usually due to some blockage in the circulation of the cerebro-spinal fluid within the brain. The most common sites of this blockage are the interventricular foramen between the lateral and third ventricle, the Aqueduct of Sylvius, and the roof of the fourth ventricle. Should the blockage occur at the interventricular foramen a unilateral condition develops where the pressure atrophy is limited to the one cerebral hemisphere. In some cases the blockage is seen to be the after effect of chronic meningitis,

lesions of syphilitic or tubercular origin, or some structural malformation. In children primary chronic hydrocephalus of uncertain pathology is seen, but there is usually a chronic ependymitis supposedly of hereditary luetic origin.

Some adult and congenital cases are found where the condition involves the spinal cord as well as the brain. This may be due to an increased production or decreased absorption of the fluid.

Pathology.

The increase in pressure of the fluid within the ventricles causes a pressure atrophy of the cerebral tissue. Also the circulation through the skull is decreased and the brain suffers from lack of nutrition. The principal distention is of the lateral ventricles. Congenital hydrocephalus extends these in their long diameters, and the posterior horn is frequently pushed back until it is within a short distance of the surface. On the other hand, acquired hydrocephalus is said to increase the ventricles in their cross and vertical diameters. The medullary matter forming the walls is hard and tough, and the ependymal lining is usually greatly thickened. The amount of cerebral substance may be reduced until it forms the cyst-like wall, a fraction of an inch in thickness, for large cavities which may hold as much as three gallons of fluid. The basal ganglia and the cerebellum may also be compressed. Also, if the third and fourth ventricles are involved the optic tracts suffer atrophy. In many cases the auditory nerves are also atrophic. Also, hypopituitarism due to pressure atrophy is found.

In many cases the skull is found to be quite thin and the bones may be widely separated. Wormian bones are commonly found.

Clinical Findings.

The typical hydrocephalic is a person with an undersized body and having a head enlarged in all directions and of a

characteristic globular shape. This gives them a peculiarly top-heavy appearance, and in some cases the head cannot be held erect. The scalp usually appears shiny, due to the stretching, and the hair is, in most cases, somewhat thinned. A common finding is a bulging at the base of the nose, but the greatest circumference is at the level of the temples. The circumference varies from a little above normal up to 30 inches, but the average is about 24 inches. There is no relation between the circumference of the skull and the degree of mental impairment. In children below 6 years with this condition, large bulging fontanelles are found. Due to the outward tilt of the frontal bones, the eyes are, in most cases, directed downwards. Choked discs are reported to be common. A large number of varying nerve lesions can be found, but the most common is some interference with the pyramidal pathway. The reaction of the pupil to light may be absent in one or both eyes and the pupil dilated. Blindness is seen from optic nerve atrophy when the condition involves the third and fourth ventricles. Nystagmus, due probably to some destruction of the vestibular branch of the auditory nerve or cerebellum is a common finding. Strabismus is frequently seen. There is usually general body weakness and wasting with spastic paralysis, particularly of the lower extremities. Ankle clonus can frequently be demonstrated and epileptoid convulsions are of serious importance in the more acute cases.

Prognosis.

The condition presents a varied course. The congenital cases may terminate in a few weeks, while others come to a standstill, and some degree of adult development may result. As a general rule, marked hydrocephalics do not reach maturity, but give out at puberty or adolescence, if not soon after, with convulsions and comatose conditions referable to intracranial pressure.

An Introduction to Radiotherapy.

By A. D. IRVINE, B.A., M.D., '31.

Radiotherapy may be defined as the treatment of disease either by X-rays or by rays given off by radio-active substances, the most important of which is radium.

Physics.

In such a complex atomic system as in uranium, where there are 238 protons and 238 electrons involved, a very intricate structure must result, especially if one considers the forces coming into play. Protons repel each other, but attract electrons, and electrons repel other electrons but attract protons. In addition there are gravitational, magnetic, and centrifugal forces acting on the system. All these complex forces of repulsion and attraction must be nicely balanced, otherwise the uranium atom would not be stable enough to be identified. In truth it is not entirely stable, and its atom occasionally spontaneously breaks up, and new atoms are formed of less complex structure. The property of thus spontaneously breaking up with the accompanying phenomena, to be described later, is called radio-activity.

Radio-activity is exhibited by all elements above the atomic weight of 209, that is above Bismuth in the Periodic Table. This property is due partly to the complex atomic structure rendering it unstable, and partly to some peculiar structural arrangement of the protons and electrons. This latter explains why some substances are more radio-active than uranium although they have a lower atomic number.

As just suggested, radio activity manifests itself by the explosive change of one atom into another of less complexity which contains a smaller amount of potential energy. So at the same time it must liberate kinetic energy in the process. A radio-active element is therefore gradually and constantly changing itself spontaneously,

quite independent of environmental conditions. The gradual change is due to the sudden explosion of a certain percentage of the atoms of the element per unit time. In other words, we cannot tell what particular atoms are going to explode in a certain period, but we do know how many of them will do so. This rate of change is different for the different radio-active elements, but is constant and characteristic for each. Also we can estimate the average expectation of life of the atoms of a radio-active element in the same manner that a life insurance company can do so for its clients. For radium this is 2,400 years. The degree of radio activity is a measure of the rate of change of an element.

Historical Review.

By 1896, a year after the discovery of X-rays, it had been discovered that X-rays ionized gases, and that uranium rays had the same property.

Mme. Curie tested all the known elements and found that only uranium and thorium were radio-active. Further investigation led to the conclusion that radio-activity was an atomic phenomenon and was independent of the chemical combination of uranium and of external conditions.

Only a few words need be said concerning the development of the X-ray tube from the Crooks tube with which the ray was discovered. Roentgen interposed a metallic anode or anticathode in the tube so that the cathode rays would impinge on it rather than on the glass wall of the tube. The difficulty in using such a gas tube, as it was called, was that the degree of vacuum within the tube had to be nicely adjusted to about one-millionth of an atmosphere. When the rarefaction was less than that, the X-rays lost their penetrating quality, and when the vacuum became more nearly perfect

the tube would no longer conduct a current of electrons.

In 1912 Coolidge modified the old gas tube and revolutionized X-ray work. The Coolidge tube is as completely exhausted as possible. In it is a filament, heated by a filament circuit. The electrons thrown off by the heated filament are impelled by a secondary high voltage circuit. The cathode is concave and shaped and placed so that the electrons forming the cathode rays, travelling at right angles to the surface of the cathode, are focussed at a point on the anti-cathode, called the focal spot. The impinging of the cathode rays on the focal spot of the anticathode generates X-rays — so by focussing the cathode rays to make the focal spot a very small one, a point source of X-rays is obtained for all practical purposes. All recent modifications of the X-ray tube have as their aim the perfection of a tube which will stand very high voltages, and of an anticathode which will withstand the terrific heat produced by the bombardment of the cathode rays on a pin-point focal spot.

The Radium Series.

The radio-active series, as before stated, consists of the elements with an atomic weight above that of bismuth. They can be divided into three series, the uranium, thorium and actinium series. Radium is a member of the uranium series. This series contains fifteen members, the first of which is uranium and the last is lead. In other words, an atom of uranium will successively pass through all these stages to finally become an atom of lead.

Ordinarily, when we speak of "radium" we are including nine members of this series, each a disintegration product of the number above it.

Radium Radiations.

It has already been pointed out that a radio-active substance is continually losing potential energy. Since energy

neither can be created nor destroyed, it is evident that the loss in potential energy must be exactly balanced by the kinetic energy produced. In radium this kinetic energy takes the form of three types of radiations, the so-called alpha, beta and gamma rays.

Both alpha and beta particles produce ionization in their passage through matter. That is, by colliding with the atoms of matter they break them up and tear off electrons. This phenomenon of ionization is, of course, most noticeable in gases. The alpha particles pick up two of these electrons freed from other atomic systems and become helium atoms.

The gamma rays are different from the first two in that they are composed of ethereal or electro-magnetic waves and not of particles of matter. They are produced by the atomic explosion which leads to the emission of the beta particle. We might use as an analogy the firing of a rifle. The bullet is the beta particle and the report the gamma radiation spreading in all directions. The gamma radiation constitutes 4.7% of the energy emission of radium. It has the same velocity as light or any other electro magnetic vibration. The shorter the wave length the more penetrating is the ray.

In passing through matter the gamma ray is gradually diminished, not by its velocity becoming less, as in the case of the alpha and beta particles, but by its amplitude of vibration becoming less. To use the analogy of the rifle again, let us suppose that a bullet is shot into a dense thicket. The velocity of the bullet is rapidly reduced to zero as it penetrates the thicket because it strikes foliage, twigs and branches. The report, however, penetrates much further, becoming less intense as the sound is absorbed by the thicket, and following the law of the inverse square.

Although the gamma ray constitutes less than five per cent. of the energy emission of radium, it is the one of most interest to us, because of its great penetrating power.

X-rays.

In an X-ray tube the cathode rays are merely electrons under the influence of the very great voltage applied to the tube, and consequently traveling with a great velocity. Whenever in nature electrons are suddenly stopped or started, there are set up vibrations in the ether called X-rays. These vibrations travel out in all directions, with the velocity, and obeying the laws, of light.

The velocity of the electrons impinging on the anti-cathode is determined by the voltage applied to the tube. The wave length of the X-rays produced is a function of the velocity of the cathode rays. The penetrating power of the X-rays produced is in turn dependent on this wave length. The longer wave lengths, the so-called soft X-rays, have not as great a penetrating power as the short wave lengths or hard rays. The greater the potential applied to the tube the shorter the wave lengths produced, that is, the harder the rays and the more penetrating they are.

Comparison of X-rays and Gamma Rays

The origin of both these rays is related to the electron, as already pointed out. The X-ray is produced when a cathode ray — that is, an electron travelling at high speed — strikes the anticathode and is thereby suddenly stopped. The gamma ray of radium is produced when a beta particle — which is merely an electron masquerading under another name — is suddenly shot off from its orbit by an intra-atomic explosion.

Both types of rays are electro magnetic vibrations. In order to understand their relation it is profitable to recall that the electro-magnetic vibrations form a long series with a gradation of wave lengths. This series has been arbitrarily divided into zones. The zone with the longest wave lengths is called Hertzian waves — some of which have wave lengths in the vicinity of 1,000,000 kilometres. The wireless

waves are the next in the series, and their wave lengths are expressed in metres. Next comes the infra red, visible light, ultra violet, and so on down to X-rays, and lastly gamma rays. All the members of this series differ only in wave length.

A special micro-unit is necessary for describing the wave lengths of the shorter waves. It is the Angstrom unit, and is equal to one hundred millionth of a centimeter. Visible light ranges between 7,700 and 4,000 Angstrom units. X-rays range from 6.9 units for the softest rays to 2.5 for the hardest. Gamma rays begin at 2.5 units and range down to .01 units. This gives some indication of the inconceivably short wave lengths of these rays, and gives us our explanation of why they can penetrate matter by passing through the inter- and intra-atomic spans. They are the shortest wave lengths known to physicists. It has been estimated that if a tube could be built that would operate under a load of about two million volts, hard X-rays with the wave lengths of gamma rays would be produced.

Because of the similarity of the rays, it matters little from a physiological standpoint which type is used.

Interaction Between Radiation and Matter.

It is necessary to briefly consider the interaction between these rays and matter. A beam of these rays in passing through matter suffers a decrease in its intensity due to three causes:

1. Loss of energy due to true absorption.

2. Transformation of energy due to scattering. Although gamma rays cannot be reflected nor deflected by mirrors, lenses or prisms, they are reflected by the surfaces of the molecules of matter through which they are passing.

3. Transmittal of energy to secondary radiation. We have seen that whenever beta or cathode rays, that is, high-speed electrons, are suddenly stopped or started, rays of the gamma and X-ray type are produced. The re-

verse can also occur, so as a result beta rays are produced whenever gamma rays traverse matter. It would seem that the vibrations of the gamma rays are such that they can harmonize, or are in resonance with the atomic systems, and by their energy can break up some of the systems freeing electrons, or, as they are called, beta rays. This power illustrates the kinetic energy possessed by the gamma vibrations. We have all seen something of the energy that can be transmitted by vibrations. These may help us to understand the production of beta particles by gamma vibrations, but they are not to be considered as analogous. Such an example would be the production of a sympathetic note on a piano as a nearby violinist produces that note on his instrument. The piano wire with the proper frequency responds, but not violently enough to be damaged, as is the atomic system acted upon by gamma radiations.

The secondary rays of the beta-cathode type in turn can give rise to other gamma rays, which in turn give rise to more beta rays, and so on. The ratio of energy transformation from one type to the other is very small, so the secondary radiation is not very conspicuous from the energy standpoint. But it must be remembered that it may assume great practical importance, because the secondary beta rays are easily absorbed and so may produce effects out of all proportion to their energy content.

Result of Absorption of Radiation.

Since matter absorbs energy from radiation, we naturally expect to be able to detect some of the results of the absorption. Although it manifests itself in several ways, such as heat or chemical activity, we shall consider only one, namely, Ionization. At the basis of this consideration is the fundamental fact that irradiation exerts its influence on the atoms of matter.

The nucleus of the atom may be affected, thus giving an artificial transmutation of the elements. Generally,

however, the planetary electrons of the atom are affected. Some are blasted out of their orbit. There is good evidence to show that only alpha and beta radiations can produce a total demolition of the atomic system. This would indicate that the action of gamma irradiation on matter is an indirect one and takes place through the intermediary of the secondary beta rays produced.

Atoms which have been ionized are in a more favorable condition to react chemically. As a natural consequence, therefore, the radiations produce chemical changes, even in inorganic substances. Living tissues, with their extremely complex molecules, and depending on more or less critical interlocking of chemical reactions, are therefore much more apt to be affected by radiation. This may explain why biological changes can be brought about by relatively small doses of irradiation as compared to that required to produce perceptible changes in inorganic substances.

Before the physiological action and effects of radiation are discussed, there are several practical considerations we must bear in mind.

Radium Standard.

A radium standard is necessary both for commercial and therapeutic purposes. It seemed desirable to utilize the radio-activity of the substance as a measure of its potency. This can be done by utilizing the ionization current produced in a gas. The alpha and beta rays are filtered out by a suitable filter. This leaves the gamma rays, which, after all, are the ones of prime importance from a practical standpoint in therapeutics. So given a specimen whose radium content is known, it is possible to determine the radium content of another specimen irrespective of its purity by comparison of the ionization currents or rates of fall in a gold leaf electroscope.

The amount of radium in the preparation to be tested is expressed as so many milligrams of radium element.

Kind of Radiation.

It is not sufficient, simply to say "X-ray" or "radium rays" in prescribing irradiation, for the radiations from these are complex. Practical requirements are met by specifying the filtration, for this determines the kind or quality of the radiation.

Filters have been constructed of various thicknesses of many substances, the chief of which are rubber, aluminium, copper, brass, zinc, platinum, gold and lead. The chief use of filters is to absorb the less penetrating rays which injure the skin in deep radiotherapy. By removing these rays it is possible to use large doses of irradiation on the deep tissues without excessive injury to the superficial tissues.

In deep X-ray therapy it has been found that a filter one-half to three-quarters of a millimetre of copper, with a tube voltage of about two hundred thousand volts, is a good working range. When using radiant energy, the container of the radio active substance may be used as a filter, and the walls made of a suitable thickness of the filter material. In other cases the glass tube containing the substance is placed within a filter chamber. Only the radiation which comes out of the container is of value. This is only a small fraction of the total amount of energy emitted by the radio-active substance, as pointed out before. This loss is of no particular significance, except from an economical point of view. By using gold or platinum containers they can be made very small and yet absorb all but the penetrating gamma rays.

Amount of Radiation.

In dealing with radium, the amount of radiation the lesion is receiving depends upon the mode of application, a term which includes six factors. These are:

1. The quantity of radium. This requires no explanation, for obviously the radiant energy varies directly with the amount of radium used, other things being equal.

2. The direction of the irradiation. Here, too, the amount of radiation must vary directly with the time.

3. The filtration. As pointed out above, the greater the filtration the greater the penetration of the radiation.

4. The distance or spacing. This is of importance for two reasons. Firstly, because irradiation varies directly as the square of the distance from the source. Thus the radiation at 1 c.m. is a hundred times more intense than at 10 cms. Secondly, because the more tissue that intervenes between the source of radiation and the cells to be acted upon, the more absorption and scattering of the radiation. The scattered and secondary rays produced in this manner are less penetrating, hence biologically more effective. The contribution, by scattering, to the amount of radiation effective at a depth, increases with the depth, and may become larger than the amount of radiation arriving there by direct transmission of the original beam.

5. The geometrical configuration of the tissues. Thus a flat large tumour mass will receive much more radiation if the rays are striking it broadside than if they are travelling in the long axis of the lesion.

6. The absorbing power of the tissue. It may be said that all tissues, with the exception of lung and bone, have about the same absorbing power. This is about the same as that of water or of pure gum rubber. Roughly, four inches of tissue absorbs half of the radiation that is used in deep radiotherapy. Much has been made of the great susceptibility of neoplasms, but it remains to be proved that such a tissue actually does absorb more radiation than normal tissue.

So it becomes evident that it is not sufficient to say that a certain number of milligram hours were used in describing a treatment, for this only includes two factors, the quantity of radium and the time. In order to obtain duplicate results more specific information is necessary.

What has been said here about radium will apply for the most part to deep X-ray therapy.

Mode of Administration.

By this is meant particularly the time spacings of the irradiations. The same total amount of radiation may be administered at one time or by several fractional treatments. In either case each treatment may be long or short, depending on the amount of radiation administered. In general it is possible to vary the time within wide limits if it is desirable to do so. The question is to determine the mode of administration of the irradiation which will yield the best results in a given type of case. To decide whether a heavy radiation for a short time or less intense irradiation for a longer period is the better method of combating any type of lesion, is clinically very difficult. This accounts for the wide difference of opinion among radiologists on this subject. It is a question which will only be settled as our clinical experience increases.

There is a unit of dosage which has a physiological basis. This is called the Erythema Skin Dose. It may be defined as: "That amount of radiation which will be followed in eight or ten days by a faint reddish blush of the skin, which rises to a maximum of colour in about sixteen days, and then, without vesication or other visible damage to the skin, fades away, leaving a brownish pigmentation, which in turn disappears in a few weeks." Of course in using such a unit allowance must be made for a normal wide variation of individual skins.

The usual manner of prescribing radiation by radium is to order so many milligram-hours — which is merely the product of the amount of radium by the time — and state in what manner it is to be administered. In deep X-ray therapy one must take into account the voltage applied to the tube, the milliamperage, the time and the distance of the tube from the lesion. It is possible to translate these factors into a

formula which will give an average erythema skin dose.

Methods of Administration of Radiation.

Radiotherapy may be administered in several ways. The more important ones will now be mentioned.

1. Deep X-ray Therapy.

High voltages are used and the rays are heavily filtered. The resultant hard rays have great penetrating power and have a minimal effect on the superficial tissues. Also by cross-fire irradiation, that is, by directing the beam of X-rays toward the tumour from different angles, a maximum amount of effect may be produced on the deep-seated tumour without delivering an injurious dose to any one part of the surface tissues.

2. Radium Bombs.

In these a quantity of radium, say from 50 mgm. to 500 mgm. of radium is placed in a large block of lead. On one face a cylindrical or funnel-shaped opening leads from the centrally placed radium to the outside. The radium rays are given off in all directions, but the only effective ones are those escaping through this opening, so this gives a method of directing the radiation in whatever direction it is required. The hardness of the rays is determined by the filter surrounding the radium in the centre of the lead bomb. These bombs may be made in various sizes and shapes. Some are so constructed that they can be introduced into a cavity, thus approximating the source of radiation to the site to be treated. By using several bombs a cross-fire irradiation on the tissue is produced, thus increasing the effect with a minimum of injury to the intervening tissues.

3. Radium Tubes.

These are merely tube containers made of some filtering material, such as aluminium or brass, in which the radium is placed. They are held in place by adhesive or bandages.

4. Radium Needles are made of glass, aluminium, gold or platinum, and contain small amounts of a radium salt, usually one milligram in each linear centimetre. They are usually inserted in parallel rows about a centimetre apart, in the area to be treated. When made of glass or aluminum the rays emitted are very soft, and usually result in much necrosis and sloughing. When made of platinum or gold hard rays are emitted, by virtue of the great filtration power of these metals, which seem to have a lethal effect on the neoplasm without markedly injuring the normal tissue. Threads are fastened to the needles so that they may be withdrawn after the desired time has elapsed.

5. Radon Needles.

These are fine capillary tubes containing radon gas, which is made from the chloride of radium. They are inserted into the tumor mass in the same manner as radium needles. It is not necessary to withdraw them because of the short life of the radon.

6. Radon Seeds.

These are very short lengths of capillary tubes, each of which usually contains one milli-unit of radon. In using them an attempt is made to place them in the tumor mass at intervals of one centimetre between them in every direction — a very difficult procedure.

7. Packs.

These are frames of metal, or other material, in which are placed tubes of radium, radium needles or radon needles. In most respects they are similar to radium bombs.

Action of Radiation on Tissue.

The exact ultimate manner in which radiation causes changes in tissue is not known. As pointed out earlier in the paper, the action of radiation is due to the production of secondary radiations by the primary gamma or X-rays.

The absorbed energy of the radiation producing strong biological effects is

very small, and amounts to a few calories only. From this fact it can be concluded that the energy cannot act as a uniform increase of temperature throughout the biological medium. It must, instead, be dissipated at discrete, very small points. This idea of the action of rays at discrete points is supported by the experimental fact of physics that the action is caused by the impact of electrons against atoms. We know that when electrons strike a mass, heat, the lowest form of energy is produced. So we may regard the action of radiation as the production of heat at discrete very small points, that is, intramolecularly. Large, complex, none-too-stable molecules, such as the protein ones, react readily to the impacts of the secondary beta particles and the couplings between its component parts are diminished and broken by the bombardment.

That radiation will destroy cancerous tissue is a fact accepted by all investigators. But whether radiation has a selective action on malignant neoplasms is a controversial subject, and one that cannot as yet be regarded as settled. Radiation, it is true, will destroy malignant tissues in many instances, apparently leaving the normal tissues intact, thus giving the impression of a selective action. If a sufficient dose is used it can be shown at any time that benign growths and normal tissue can be destroyed equally as well.

One group of investigators believes that the action of radiation is to destroy the life of all cells, benign or malignant, plant or animal. This group will not recognize that radiation can exert a stimulating effect on cells, or any other effect except an injurious one. It claims that radiation will only injure and destroy cell life, and the more easily the cells are injured the more easily they will be killed. There is nothing specific or at all selective about the action of radiant energy. Most cancer cells are more easily killed than most normal cells, it is true, but the action is merely one of degree, not of kind.

On the other hand, other investigators believe that irradiation has a specific selective action on malignant cells. Their aim is to obtain the type of irradiation by filtration or by the proper high voltages which will have the most deadly effect on the tumour cells, and hence be the least injurious to normal tissue.

Careful investigators, as Ewing, who have followed the histologic changes of tumor cells following irradiation, claim that these changes are not duplicated in normal tissue, and so must indicate a specific and selective action on malignant tissue cells. We cannot help but hope that this second view is the one more nearly correct, because it holds a greater promise of successful treatment as the science of radiotherapy progresses.

But regardless of the camp to which they belong, all investigators recognize the truth of the generalized statement which is known as the Law of Bergonie and Tribondeau, which says: "Immature cells, and cells in an active state of division, are more sensitive to irradiation than are those cells that have already acquired their fixed adult morphological and physiological characteristics."

So in general, tumours that are made up of a large proportion of embryonal cells, or cells which are rapidly dividing so have not time to reach maturity, are more susceptible to irradiation. So it is possible by a microscopic examination of a section of a tumour to predict the effect of irradiation. Also, it has been shown fairly definitely that cells in the actual process of mitotic division are five to eight times more sensitive and vulnerable than during their resting stage. In passing, one may point out that this would seem to be an argument in favour of using comparatively small doses of radiation and prolonging the treatment sufficient to cover the life cycle of the neoplastic cell.

Histologic Changes.

But although we can only speculate on the ultimate mechanism of the action

of irradiation, the histologic changes following this treatment are very well known.

The first effect is an inflammation. There is a swelling of the nucleus of the malignant cell, then a degeneration, with a breaking down of the nuclear capsule. This allows fragmentation of the nucleus. This is especially seen in nuclei undergoing mitosis. Cell division is almost instantly checked after irradiation. The chromosomes split, and the spindle threads rapidly disintegrate. While this has been going on there has been produced an edema of the cell proper and degeneration of the cytoplasm, which shows hyperchromatosis, vacuolization and hydropic swelling. So both cell body and nucleus are obliterated.

The stroma also undergoes changes. First it becomes edematous and then hyperemic. Soon a marked leukocytic infiltration is present. According to most investigators, new capillaries appear and numerous fibroblasts develop. Sometimes the stroma cells appear to be destroyed also if the irradiation is very intense, but usually they seem to be only stimulated.

In successful irradiation of a carcinoma the tumour is finally destroyed, and its place is taken by fibrous connective scar tissue. This is the aim of radiotherapy. Even if the neoplasm is not entirely destroyed, the formation of connective tissue is marked and important, for it frequently encapsulates cancer cells. As the cicatricial tissue contracts to a large extent it obliterates the vessels and so cuts off the blood supply to the tumour cells. In addition the fibrous tissue acts as a mechanical barrier and temporarily checks the advance of the neoplasm. This formation of connective tissue is sometimes so marked that some of the earlier observers were of the opinion that the primary action of irradiation was to produce fibrous tissue, and that, as a result of its contractibility, the neoplastic cells were squeezed out of existence.

Summary.

1. A knowledge of the Atomic Theory and of the atomic structure of radio-active substances gives a partial explanation of the phenomenon of radio-activity

2. The gamma rays of radium and X-rays differ only in wave lengths, so often from a biological standpoint, it matters little which type of rays is used.

3. In passing through tissue, some of the energy of radiation is absorbed and produces biological effects.

4. Immature cells, and cells in an active state of division, are more sensitive to irradiation than cells with adult morphological and physiological characteristics.

5. Although tumour cells for the most part have a smaller minimum lethal dose of irradiation than normal cells, it yet remains to be proved that irradiation is a specific for malignant cells.

6. In prescribing irradiation, it is necessary to specify the kind of radiation and the amount, and the mode of administration.

Historical Sketch of the Theories of Hearing.

By PAUL M. O'SULLIVAN, M.D. *

The knowledge of Otology exhibited by the masters of classical antiquity is conspicuously meagre. This appears all the more noticeable in contrast with the wealth of treatises on the sister study of Ophthalmology. Aristotle's teaching regarding the organ of hearing may be stated in a few words. The external ear, being such an obvious structure was well known and names given to the various parts. The external auditory meatus was also well known, together with the membrane at its farther end. Beyond this membrane, the existence of a small chamber filled with air was recognized and perhaps it may be a matter of surprise to find that Aristotle knew of the existence of the so-called Eustachian tube. In the first book of his "Historia Animalium," he says: "There is no opening to the brain from the ear, but there is one to the palate of the mouth." The middle ear was looked upon as the essential organ of hearing. The air contained therein was called *aer complanatus* or *aer congenitus*, and the vibrations of this enclosed air, communicated to it by the sound entering the meatus, gave

rise to the sensation of hearing. This theory was universally held until the time of Cotugno in the 18th Century. But, regarding the internal ear, enclosed as it is, in a bone of stony hardness, which defied investigation, the petrous part of the temporal bone—the knowledge of the ancients was nil. The only accession made by the Greeks to the Aristotelian tradition was that of Orbasias, a Byzantine of the fourth century, who described the internal auditory meatus and the course of the 7th and 8th nerves.

Over a thousand years passed before any new information was available and the first contribution after this long period of inactivity was afforded by Alessandro Achillini (1462-1525), a pupil of Mendinus. In his "Opera Omnia" published in folio at Venice in 1508, Achillini describes two of the auditory ossicles, the malleus and incus.

Shortly after, Giovanni Fillipo Ingrassias (1510-1580), a pupil of Vesalius, added the stapes in 1546. Realdus Columbus also lays claim to this discovery in his work "De Re Anatomica," where he says "His tertiam (sc. ossiculum) accedit nemini, quod sciam antea cognitum."

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A fourth auditory ossicle, now known as the lenticular process of the incus, was described as the "os orbiculare" by Franciscus Sylvius (1644-1672).

The next advance was made by Gabrielle Fallopius (1523-1562), who described and named the cochlea in his work, "*Observationes Anatomicae*," published at Venice in 1561. The aqueduct of Fallopius recalls his researches on the ear.

Bartholommeo Eustachi (1521-1574), professor of medicine at the Collegio della Sapienza, at Rome, and papal physician, as early as 1563 clearly depicted the middle ear and its contents and also gave an accurate description of the tuba auditiva, to which his name is indelibly attached in spite of the B.N.A. Unfortunately he died before he could publish his findings, and for 150 years his beautiful and accurate plates lay neglected in the Vatican library. However, in 1714, the reigning pontiff, Clement XI commissioned his physician, Lancisi, to edit these priceless drawings, which were published in that year in Rome in a splendid folio volume.

Caecilius Folius (1615-1700), professor at Vienna, added details to the anatomy of the semi-circular canals and gave his name to the long process of the malleus, sometimes called the processus Folii.

The semi-circular canals were known to Empedocles. The term labyrinth has an interesting origin. It is not Greek but of Minoan derivation. Recent excavations at Knossos, in Crete, at the site of the traditional palace of the Minotaur revealed an immense throne room in which the motif of the frieze around the walls was that of a double-headed axe, which was termed the labrys. Hence this hall was called the hall of the double-axe, and transferred to the entire building as the labyrinth.

Another minor structure, the Glaserian fissure, was described by Johann Heinrich Glaser (1628-1675) in a book published after his death, "*Tractatus posthumus de cerebro*," 1680. He gives an extraordinary theory regarding the

formation of cerumen. He says: . . . a bitter excrement is formed in the cortex of the brain which passes to the ear with the auditory nerve. From here it passes to the parotid gland by way of this fissure. After being imbibed by parotid it is spewed out into the auditory canal as wax." (Perhaps this is the etymology of cerumen from cerebrum.) With the anatomical basis to work on, there follows, in chronological order, the work of three great men in the history of Otology.

The first is Antonio Maria Valsalva (1666-1723) of Imola, Professor of Anatomy and Surgery at Bologna. His classical monograph on the ear entitled "*De aure humana tractatus*" was published at Bologna in 1704. We have a copy of this classic in our library and it is interesting to note, on the title page, the Imprimatur of a consultor of the Holy Inquisition. Bologna, you will remember, was a papal university. In the fifth chapter—on the use of the Eustachian tube—is to be found the original account of Valsalva's experiment.

His physiology reads like a modern text book. "Sound," he says, "whether it be due to Vibrations or Tremors, Undulations or what you will, are collected by the external ear and directed down the meatus to the tympanum. The vibrations of the tympanum are communicated to the membrane covering the foramen ovale and thence up the scala vestibuli and down the scala tympani to the membrane closing the foramen rotundum."

He performed experiments on animals, showing that a dog could still hear after destruction of both drums, though not so clearly.

He was greatly intrigued by the question of the possibility of communication between the ear and the cranial cavity. Injecting tobacco smoke fumes (*fumus Nicotiana*) up the Eustachian tubes in the cadaver, he found it issuing into the cranium and supposed that the passage was by way of the mastoid cells.

Domenico Cotugno or Cotunnus (1736-1822), Professor at Naples, the second of this triad, published in 1775 a work entitled "*De aquaeductibus auris humanae internae*," in which he showed that the internal ear was filled with fluid and not with air. Hence the endolymph is sometimes called the *Liquor Cotunnii*. In this work he anticipated many of the theories later brought out by Helmholtz.

Lastly, Antonio Scarpa (1747-1832) professor of anatomy and surgery, first at Modena and later at Pavia, wrote two important tracts on the ear, namely, 1. "*De structurae fenestrae rotundae auris*," Modena, 1772. 2. "*Anatomicae disquisitiones de auditu et olfactu*," Pavia, 1789, fol.

Further development of the knowledge of the ear depended upon microscopic examination and a nobleman, the Marquis Alfonso Corti (1822-1888) of Sardinia, described the receptor end organ of hearing in 1857. This paper was published in the "*Zeitschrift für wissenschaftliche Zoologie*."

Now, as to Physiology:

Savard showed experimentally that the tympanic membrane vibrated in accordance with the sound waves which reached it from the external ear.

Helmholtz explained the leverage action of the auditory ossicles, and postulated a scale of pitch perception varying from the high notes at the base of the cochlea and the low notes perceived through the upper part.

The physics of sound were founded by Morin Mersenne (1588-1648), who formulated the law governing the vibration of strings—known as Mersenne's Law.

Sir Francis Galton (1862-1911), the anthropologist, introduced his whistle to measure the limits of audibility.

Ernest Chladni (1756-1827) showed that sound was carried by air and that a bell suspended in a vacuum did not produce any sound when struck. He also determined the velocity of the transmission of sound in the air.

With an accurate account of the anatomy of the ear and the fundamental principles of Acoustics available, a full synthesis was possible and this was achieved by the great Helmholtz. Every branch of the physiology of the special senses has been enriched by the labours of this giant intellect. His work on the sensation of tone was published in 1863 and this date marks the beginning of modern conceptions regarding the function of the ear.

Sedimentation Time—A Brief Discussion.

By P. B. AYRES, B.A., '32.

History.

The phenomenon of sedimentation was known in the time of Hippocrates and Galen, as is shown by their observations on the separation of whole blood into various layers. These early scientists also noted that blood from diseased persons had a surface layer differing in appearance from that obtained from the blood of a healthy individual. They assumed that disease was due to an increase in any percentage content of the four constituents of the blood, of which the surface layer

was one. Since that time, many observations have been made through the ages on coagulation, sinking velocity of corpuscles, and the causes of increase in quantity of this upper layer.

In 1917, Fabraeus accidentally observed an increased sedimentation or velocity of the red corpuscles during pregnancy, and his original paper and subsequent researches have stimulated a great deal of investigation along this line. That this phenomenon has a distinct place in medical laboratory investigation is beyond doubt, although com-

paratively little attention has been given to it on this continent, whereas in Europe it plays a large part in clinical laboratory methods.

Methods.

Fahraeus refers to Westergren's method, in which one-fifth of a c.c. of 3.7% solution of sodium citrate is mixed with four-fifths of a c.c. of blood, obtained by veni-puncture. This mixture is transferred to a small test tube, and gently inverted several times. The citrated blood is now sucked into a long thin glass tube, 2.5 m.m. in diameter and with a height of 200 m.m. The tube is then placed vertically on a stand so that its tip rests on some impervious elastic material, i.e., soft rubber, cork, plasticine, and is clamped there in position. The sedimentation velocity is measured as that distance through which the uppermost layer of the red corpuscles from the upper meniscus of the fluid column passes in a given time. The procedure in use in the hospital here is that suggested by Friedlander. The tube is .5 c.m. inside diameter, and a little over 1 c.c. in capacity. It is graduated at the 1 c.c. level, and at levels of 6, 12 and 18 m.m. below this level. 0.2 c.c. of 5% citrate is first added to the tube, whence venous blood is added to the 1 c.c. mark. The tube is gently inverted several times and allowed to rest in a rack as before, whence the time required for the upper level of the corpuscles to sink to the 18 m.m. mark is noted. Sixty minutes is here taken as normal. Hence we have sedimentation velocity, (normal 7-10 m.m. per hour) and sedimentation time. These must not be confused when interpreting results.

Theory.

Changes in sedimentation time are manifestations of altered suspension stability. The various factors that play a part in these changes cannot be here fully discussed.

A full discussion of the hydrodynamics of sedimentation, causes of increased rouleaux formation, and the

part played by surface tension, the red cell clumping in the streaming blood, its manner of flow in the capillaries, etc., may be found in Fahraeus' Monograph.

It must be sufficient here to point out several of these observations:

1. That the viscosity of the blood seems to have clinically little to do with changes in sedimentation time.

2. That the size of the red cells is not of significance, but that the size of the rouleaux, and their formation, is of great importance in increasing the velocity.

3. That red cell concentration becomes of importance only in cases of marked polycythemia where low figures are the rule, but in marked oligocythemia increased velocity is also found. The sinking velocity in normal and pathological blood is influenced by the hydrophile colloids of the plasma, the proteins,—the degree of clumping depending on the ratio of these proteins. There is a normal balance in the percentage content of the plasma as regards these proteins, serum albumen, serum globulin and fibrinogen. An increase in the globulin is the chief factor in increasing the sedimentation velocity. An increase in fibrinogen acts the same way to a lesser degree, whereas an increase in the albumen lessens the velocity. It should be understood that these increases are only relative, the total amount of protein in the plasma remaining constant. Why these changes in percentage content occur in the various pathological processes to be discussed, is still problematical.

4. The rouleaux formation is due to:

- (a) A surface tension phenomenon.
- (b) The presence of electric charges on the interface between the cells and the fluid.
- (c) Hydration or dehydration of the red corpuscles.

Clinical Application.

A. Physiological.

1. This is always lowest in the newborn, where the lowest globulin values are found in the plasma.

2. Women, who seem to have a higher globulin percentage than men, have a faster sedimentation time.

3. During pregnancy the sedimentation time is markedly decreased, becoming apparent in the second month of pregnancy and rapidly returning to the normal during the puerperium.

B. Pathological.

In all acute pathological processes the sedimentation time as a rule is markedly decreased, especially in the acute infectious conditions and in inflammatory processes. In chronic infectious diseases there is a decrease in sedimentation time to some extent. In malignant tumours there is usually some decrease in sedimentation time which becomes more marked if secondary infection is superimposed on the existing condition. Several workers have attempted to discover the relation of thyroid diseases to variations in sedimentation time, but so far without any definite success.

In the province of internal medicine, the most important results obtained to date have to do with the problem of pulmonary tuberculosis. Many investigators state that sedimentation time is decreased, and while not of diagnostic value, is of great significance both in gaining an impression as to the intensity of the pathological process and in making a prognosis. It has been established that a high sedimentation velocity is indicative of an infection, the outcome of which is of grave import. This is usually a serious prognostic sign and may be taken to mean that the individual is not handling his infection well. The above pertains in some measure regardless of existing clinical manifestations. Similarly, favourable clinical manifestations should be discounted if there is a high sedimentation velocity. Dr. H. S. E. Murray reports that in 67% of cases of

open pulmonary tuberculosis with an increased sedimentation velocity under 20%, the majority of the cases progressed favorably, whereas in those cases where sedimentation time was below this (i.e. over 20% less) even where the lesion was not advanced, the tuberculous process progressed, or remained stationary in the preponderance of cases.

In the pneumonias, and especially that of the croupous variety, sedimentation velocity is greatly increased. When septic or other complications occur such as pleurisy in acute general infections, the already increased velocity is more markedly raised.

In syphilis, the velocity as a rule is fairly markedly increased.

In cholecystitis and cholelithiasis, Dr. Linton found the rate markedly increased where icterus was present from obstructive jaundice, and he noted that those patients having the lowest sedimentation time were prone to bleed after operation earlier and more freely. Hence this may be of value as regards operative interference in these conditions.

Dawson and Boots have observed that sedimentation time is an aid in the differential diagnosis between rheumatoid arthritis and osteoarthritis; in the former process when acute, the rate usually increasing to 30 m.m. per hour and paralleling the severity and extent of the lesion. Exacerbations and remissions of the disease were also paralleled closely by increase and decrease of the rate. In old, long standing or arrested cases, the rate tended towards the normal. In osteoarthritis on the other hand, the rate rarely reached to 30 m.m. per hour, and it may be noted that in non-articular "rheumatism" the rate varied only a little from the normal.

In the field of surgery, sedimentation time is chiefly of interest to the gynecologist, where inflammatory processes in the adnexa produce marked increase in sinking velocity. This, as it is well known, offers a very reliable method of differentiating the acute

lower abdominal condition caused by ectopic pregnancy, from an inflammatory process, for in the former sedimentation time is rarely altered from the normal. In local inflammatory conditions of the pelvis, the determination of the sedimentation time offers an index as to the need for surgical intervention, for it may be taken that a sedimentation time of under thirty minutes indicates the formation of pus. It is also of significance, regardless of the temperature and the white count, as regards latent infection which may be activated by operation, a time with a reading below seventy minutes being taken as indicative that complications may arise from surgical procedure (Polak and Tallfsen). In the case of post-partum pelvic infection, the sinking velocity has been of value in determining the date of discharge from hospital, patients having a time of less than forty-five minutes being considered as liable to exacerbations, if they are allowed to return home and resume their normal activities.

In regard to inflammatory processes, it may be noted that several pathologically acute appendices have been removed at operation from patients whose pre-operative sedimentation time has not shown a marked decrease.

In the province of obstetrics it is taught that an increase in sinking velocity is found in pre-eclamptic conditions. Dr. Mann has shown that this is not as effective a criterion as was supposed, he having obtained widely divergent results in two cases where eclamptic convulsions seemed imminent.

Dr. Murray made the following interesting observations from three hundred cases in regard to mental conditions:

1. That no changes in sedimentation time were observed in cases of neuroses, paranoia and manic depression, while 85% of epileptics showed a normal sedimentation velocity, 15% being retarded.

2. There is an increase of velocity in paresis, neuro-syphilis, senile de-

mentias, arterio-sclerosis, and alcoholic insanities.

3. There is a marked increase in the hemiplegias and in bulbar paralyses. She concludes that the rate of sedimentation varies directly with the amount of mental deterioration. It may be noted that there is no apparent increase in Parkinsonianism.

4. In the cases of dementia praecox this test is without much value.

Other conditions, such as whooping cough, leprosy, etc., have been investigated as to sedimentation time, in an effort to discover the diagnostic value of this test. It is interesting to speculate upon the part played in thrombosis by an increase of rouleaux formation, as shown by the increase in sedimentation time, and is here of significance in regard to eclampsia. Fahraeus believes that the pronounced polycythemia existing in eclampsia is responsible for the increased tendency of the red cells to clump, and we may note here that the increased blood pressure associated with this condition may be a compensatory effort on the part of the circulatory mechanism to counteract that tendency.

Conclusion.

1. It should be remembered that changes in sedimentation time are merely a manifestation of altered suspension stability of the red corpuscles, due chiefly to a percentage variation of the plasma proteins.

2. This test is not diagnostic of any clinical entity, but is indicative of the above-mentioned protein shift which occurs in certain pathological processes; chiefly in acute generalized infections, in acute general and local inflammatory reactions, and, to a lesser degree, in general chronic infections and toxæmias.

3. The underlying causative factor of the protein shift is not yet clear.

4. The haemodynamics of this phenomenon may vary from case to case, and are of some minor importance in the interpretation of results.

5. Sedimentation time and sinking velocity must not be confused, as they are the expressions of different methods of determining the same factor.

6. The value of the test lies in differential diagnosis, and, to a certain extent, in prognosis.

7. At present its chief clinical significance lies in the prognosis of pulmonary tuberculosis, and in the diagnosis of female pelvic inflammatory and non-inflammatory processes.

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(To whom we extend our thanks for his aid.)

Common Infections of the Hand.

By G. M. BASTEDO, M.D., and KENT HARRISON, M.D.

The common infections of the hand are Felon, Paronychia, Subepithelial Abscess, Collar Button Abscess, Carbuncular Infections, Tenosynovitis, Lymphangitis and Cellulitis, and Fascial Space Abscesses. Arthritis and Osteomyelitis are not discussed.

In the first part subepithelial abscess and tenosynovitis are discussed.

I. Subepithelial Abscess or Pus Blister.

This is an abscess formed by the raising of the epithelium from the derma by a collection of purulent exudate.

It commonly occurs about the dorsal surface of the terminal phalanx of the finger and is like a water blister which has become infected.

Treatment: The treatment is to remove completely the raised epithelium with forceps and knife. Afterwards apply a hot boracic acid or normal saline dressing, which is repeated after

soaking the finger in a hot normal saline bath for 15-20 minutes two or three times for the first day or until any surrounding redness has gone.

II. Carbuncular Infections.

Carbuncular infections in the hand are typical of those found elsewhere. *Staphylococcus aureus* and *albus* are the common causative organisms.

Anatomy: The infection probably starts in the sebaceous glands and hair follicle or sudoriferous glands. The commonest position therefore is on dorsal surface of proximal phalanx and on the ulnar side of the palm.

On the dorsum of the hand fat globules are arranged in columns at right angles to the skin, and are called *columnae adiposae*. Hair follicles with their sebaceous glands and the tortuous sudoriferous glands often course down these columns.

Beneath the derma is the areolar

connective tissue which allows the free movement of the dorsal skin.

Pathology: Bacteria enter the sebaceous or sudoriferous gland and become blocked off from outside. The exudate resulting from their growth, escapes with the bacteria most readily down the columnae adiposae to the underlying loose connective tissue. Now it spreads peripherally in the connective tissue and vertically up the proximal columnae adiposae, so forming a subterranean lake with many wells into it.

As the process proceeds the central part of the roof becomes necrotic and blows off allowing drainage. But since so many surrounding columnae adiposae are infected and each one acts as a fresh source for the spreading lake, this drainage is insufficient until the process is walled off. Walling off takes longer than elsewhere because of the looseness of the tissue.

Clinical: On the skin the following areas are sometimes seen in a carbuncle, from within outwards:—Central necrotic area, area of punctate pus exudation, area of bluish skin beneath which is pus which has not yet come to the surface and peripherally an indurated area of walling off tissue.

Treatment: The area is prepared antiseptically. For a small carbuncle a longitudinal or crucial long and deep incision is made with or without ethyl chloride freezing. This is followed by hot boracic acid or saline dressings replaced after soaking the affected part in hot normal saline for 15 minutes every 4 hours. This latter to be stopped in 24-36 hours.

For a large carbuncle a general anaesthetic is given. Crucial incisions are made extending peripherally be-

yond the area of induration. Four flaps are produced by undercutting parallel to the skin, these cuts also extending beyond the indurated area. Free slough is removed, but no skin, as skin which appears dead will sometimes recover.

Hot boracic acid moist gauze tape is packed beneath the flaps for drainage. Packing is removed in 24 hours.

The part is soaked in hot boracic acid or normal saline for 15 to 20 minutes every 4 hours of the day. This soaking is discontinued when the signs of acute inflammation such as redness and acute oedema have subsided.

The reason for cutting beyond the indurated area is not known.

In diabetic people the condition may spread seriously and treatment directed towards the control of the diabetes must be instigated with the local treatment.

III. Acute Suppurative Tenosynovitis.

This is an acute inflammation of the mucous sheaths of the tendons with the formation of pus within them.

The tendon sheaths may be likened to tubes of mucous membrane into which the tendons are invaginated from the dorsum, the edges formed by the invagination, joining around the tendon to carry its blood supply.

The sheaths of the index, middle and ring fingers extend from just distal to the distal interphalangeal joint to a line drawn between the end of the proximal palmar crease at the base of the index finger and the end of the distal palmar crease at the base of the little finger.

At the distal portion of the palm the palmar aponeurosis is arranged so that there is a sheet of dense tissue enclosing the tendon sheaths and lumbrical muscles. The sheaths extend $\frac{1}{4}$ inch proximal to this into the loose palmar tissue.

Between the tendons and this en-

closing dense tissue are potential spaces called the lumbrical canals and containing lumbrical muscles and digital nerves and vessels.

Between the sheaths and the metacarpophalangeal joints there is considerable protecting tissue which decreases distally until at the distal phalanx the sheath is in close relation with the loose connective tissue going around the bone. There is little connective tissue between the tendon sheath and the base of the middle phalanx.

The proximal end of the index finger sheath is in relation to the thenar space while the ends of the middle ring and little finger are in relation to the middle palmar space.

The tendon sheath of Flexor Pollicis Longus and the Radial Bursa are distinct from the above. The tendon sheath of Flexor Pollicis Longus extends from the base of the terminal phalanx of thumb to 1 or 2 inches proximal to the transverse carpal ligament. The part of the sheath from the head of the metacarpal to above the ligament is called the radial bursa.

The potential space in the mucous sheath is usually continuous from the terminal phalanx to above the annular ligament.

The sheath is superficial to the proximal end of the thenar space and the proximal end of the bursa is on the Pronator Quadratus.

The sheath of the little finger and the ulnar bursa are again distinct from the above. The tendon sheath of the little finger proper extends from the terminal phalanx to over the head of the 5th metacarpal, but is at least as often as not continuous with the ulnar bursa. The ulnar bursa is the proximal continuation of the little finger sheath overlapping the 5th and the base of the 4th metacarpals. It continues for 1 or 2 inches proximal to the transverse carpal ligament.

The tendons of the Flexor Digitorum Sublimis and Profundus are invaginated into the bursa from the radial side,

so that most of the bursa left is on the ulnar side.

There is, as with the other fingers, a lumbrical canal in association with the sheath, but only with the radial side in this case.

The sheath extends into the middle palmar space forming part of its superficial boundary.

Intercommunication: The intercommunication of the sheaths is important. In about 50% of cases there is communication between the radial and ulnar bursae in the carpal canal. Very rarely is there a communication between index, middle and ring fingers and ulnar bursa.

Dorsal Tendon Sheaths: Six short mucous sheaths are present for the six extensor tendons passing beneath the dorsal carpal ligament, extending about an inch above and below the ligament.

Pathology: The bacteria are usually Streptococcus Hemolyticus in the acute fulminating type and Staphylococcus Aureus in the less acute types. Rarely Gonococcus infection occurs in a blood stream infection.

The lymphatic flow in the hand is from the palmar to the dorsal surface. Bacteria enter the tendon sheaths via this lymphatic flow or by direct inoculation from a piercing wound or operative procedure.

The skin wound is often so slight as to escape notice.

Wounds over the finger creases are particularly apt to be followed by tenosynovitis, and particularly that of the middle interphalangeal joint.

Infection following a felon or arthritis is unusual. Infection may follow a lymphangitis of the finger.

After infection great changes may take place in the mucous sheaths in 6 to 12 hours or longer. These are probably due to combined effect of toxins and pressure of exudate which cuts off blood supply.

The sheath contains thin seropurulent, to thick purulent fluid. After rupture of the sheath the amount of pus is, of course, less. The wall of the sheath is congested and oedematous,

losing its shiny appearance and becoming dull yellowish white in spots of beginning necrosis.

The tendons become swollen but retain their glistening synovial covering for some time. They look like grayish strips of connective tissue when they are necrotic. Due to lack of expansion, necrotic changes are apt to first occur beneath the transverse ligament.

The whole sheath is quickly infected when any one part is, because of its continuity and the finger movements.

In the involved finger the most persistent and extensive changes occur, as besides death of tendon and sheath there is joint ankylosis and impaired nerve function.

Signs and Symptoms of Acute Suppurative Tenosynovitis.

1. Because of the reaction in the sheath and surrounding tissue there is symmetrical swelling of the entire finger.

2. Because in this position the cavity of the sheath is greatest, the finger is semi-flexed.

3. Because of increased pressure in the sheath there is exquisite tenderness over the course of the sheath.

4. And for the same reason passive extension of the finger is exquisitely painful. These four are characteristic and the following is also found:

5. There is great spontaneous pain in the finger because of effect of toxins and increased pressure on the nerve endings.

Of great importance in locating pus is the point of maximum tenderness obtained on palpation.

The following description holds true for any of the fingers: A few hours after infection the whole finger is swollen and red, with often the red streaks of lymphangitis showing on the dorsum of palm and forearm. In the less acute staphylococcic type the reaction may be more limited as the tissues have time to react to the invasion.

The greatest tenderness over the sheath is usually over the metacarpop-

halangeal joint both on pressure and extension of the finger.

The fingers not involved directly may be also flexed, but they may be passively extended without pain, unless the ulnar bursa is involved, when movement of the fingers causes pain over the ulnar bursa due to the passage of the tendons through the bursa.

The severe early spontaneous pain may subside considerably with necrosis of the sheath or its bursting and consequent decrease in pressure.

Extension of infection from the little finger sheath: This is usually as follows in order of frequency. Ulnar Bursa: Radial Bursa: Forearm: Fascial spaces: the mid palmar space or the lumbrical space: Osseous involvement, usually middle phalanx: Joint involvement, proximal interphalangeal joint usually: Rupture to the surface.

Extension of infection from little finger to ulnar bursa is denoted by the following: swelling of oedema of dorsum of the hand, fullness in palm but preservation of the palmar concavity. The greatest swelling is just proximal to the transverse carpal ligament where is situated the loosest tissue. The palmar fascia diffuses and keeps the swelling comparatively slight on the palmar surface. The swelling is due not alone to increase in size of the bursa, but also to the reaction in the surrounding tissue.

Here it may be emphasized that the greatest oedematous swelling occurs where the tissue is loosest, which is in the dorsum of the hand, and swelling there is rarely due to pus on the dorsum.

The most conspicuous and important sign is the extension of the exquisite tenderness to the area involved and found especially at the point just proximal to the junction of distal palmar crease and hypothenar eminence.

The wrist becomes flexed and the thumb becomes tender to pressure and on movement. This is due to the sympathetic inflammatory reaction in, or the actual spread of the inflammation into the radial bursa.

If the radial bursa becomes infected the four characteristic signs develop in the thumb with swelling in the thenar eminence. The index, middle and ring fingers, however, remain unchanged, except for pain on passive movement felt over the ulnar bursa, as explained above.

Tenosynovitis of Thumb Flexor Sheath and the Radial Bursa.

When the sheath of the Flexor Pollicis Longus is involved, the same four characteristic findings are present in the thumb.

With spread of the infection into the radial bursa pain is felt in the wrist on flexing the fingers, due to sympathetic inflammation in the ulnar bursa. There is some swelling on the ulnar side of the thenar eminence. Swelling usually occurs proximal to the transverse carpal ligament. Tenderness over the radial bursa may be absent, perhaps due to previous impairment of nerve function by oedema.

If the ulnar bursa becomes secondarily involved, all the fingers become flexed and tender on passive movement, particularly so the little finger. The same point of maximum tenderness found in ulnar bursa infection is again found, and usually establishes the diagnosis. This tenderness and that elsewhere over the ulnar bursa may be less than usual, perhaps due, as above, to previously developed oedema.

This involvement of one bursa by the other is common in the fulminating types of infection, but when the infection is less virulent, as with Staphylococcus, there is time for one bursa to become walled off from the other.

Pus from the ulnar and radial bursae may rupture into the fascial spaces of palm or forearm. When pus ruptures into the forearm from these bursae it lies between Flexor Digitorum Profundus and Pronator Quadratus. From here it passes upwards to area between Flexor Digitorum Profundus and the interosseous membrane. At about the middle of the arm it becomes

more superficial and passes to the ulnar side along the ulnar artery and nerve.

A brawny induration develops along the volar surface of the forearm in contradistinction to the soft oedema of lymphangitis, but the pus is too deep to allow fluctuation. If a definite ulnar or radial bursal infection has been present for 48 hours, extension should be assumed to have taken place into the forearm and suitable incisions made.

Tenosynovitis of Dorsal Sheaths: In this there is pain on movement of the fingers and on palpation of the sheaths over the wrist. No pain or tenderness on the volar surface of the wrist is present. This condition is unusual, usually following direct inoculation of the sheath.

In Tenosynovitis the systematic signs and symptoms are those of any infection and localised pus production, but comparatively slight at first.

Treatment: Prophylaxis by considering all finger wounds as possible causes of Tenosynovitis and cleaning them with Iodine and alcohol with the application of a sterile bandage.

Repeated soaking of the affected finger or the whole hand should be done if it is seen that the wound is becoming infected. This may be carried out for 20 minutes every 4 hours in normal saline or boracic acid solution, if heated so that it is hot to the attendant.

To keep the part at rest is also valuable. When the condition has developed, operation should be prompt, and erring on the side of too many thorough operations than too few.

The whole hand and wrist are cleaned with gasoline, ether, iodine and alcohol. A general anaesthetic is given and a bloodless field is procured by a blood pressure cuff around the arm.

Aseptic care of the hand is most important as the development of a secondary infection will prolong convalescence and produce more damage.

In making the incisions free drainage is the object, and the incision must be too free rather than too small.

Treatment of Index Middle and Ring

Fingers: In the early stages when only the tendon sheath is involved, the incision is a single continuous one on the radial side of the finger over the middle and proximal phalanges. The incision is extended into proximal ends of the sheaths over the tendon sheath at the base of the finger and three-quarters of an inch into the palm.

If the lumbrical space or spaces are involved, the incisions are made on one or both sides of the finger as before, but carrying the incision in the palm up the side of the tendon sheath, so opening lumbrical space and tendon sheath at the same time. It is of help in determining the extent of the pus to press over the suspected areas and watch for the appearance of pus at the incision. When the palmar spaces are involved, suitable incisions are made over them, as described elsewhere.

Treatment of Tenosynovitis of the Little Finger and Ulnar Bursa: When the little finger sheath is alone involved it is opened by a continuous incision along the radial side of the middle and proximal phalanges. When the bursa is involved it is opened by an incision extending from the distal flexion crease of the palm to the anterior annular ligament on the radial side of the hypothenar eminence.

If the pus has invaded the forearm, an ulnar incision is made in the lower third of the arm, and the space immediately ventral to the Pronator Quadratus is opened. Other incisions are made higher up if the pus has spread still further.

If the lumbrical space is involved from the little finger, the incision over the proximal two phalanges is carried into the palm over the lumbrical space for three-quarter inch. If the mid palmar space is involved it is opened by continuation of the above opening into the lumbrical space. If the ulnar bursa is involved also, it may be opened through this incision for the mid palmar space.

Treatment of Tenosynovitis of Flexor Pollicis Longus: Cut down on the

tendon sheath over the flexor surface of the proximal phalanx and continue along the sac splitting through the thenar eminence. The mass of the thenar muscles lies to the radial side of the incision. The incision is carried to within a thumb's breadth of the lower border of the anterior annular ligament, so protecting the motor nerve to the thenar muscles.

Drainage of the upper end of the radial bursa is made by radial to ulnar incisions between flexor tendons and Pronator Quadratus.

Tenosynovitis of the Dorsal Sheaths is best treated by a simple splitting of the sheath throughout its length.

After treatment: Drainage is not continued over 24 to 48 hours. Strips of rubber from a glove or vaseline-saturated iodoform gauze are best for drainage. Plain gauze soon acts as a plug and rubber tubing produces necrosis.

The hand is soaked in hot boracic or saline solution for 20 minutes every 4 hours, but as soon as possible this is replaced by dressings of half strength Keith's solution to prevent maceration of the tissues. This change of dressing may be made in three days usually.

The hand is supported in the position of function, that is, with the fingers semiflexed, thumb abducted and rotated so that its flexor surface is opposite the index finger and the wrist in the cock-up position. A Plaster of Paris dorsal splint is useful for this.

Early movement is important and should be started in 48 hours after the primary incisions, whether or not infection is present. These early movements are best done when the patient's hand is being soaked in the hot solution.

Large amounts of fluid are given the patient to stimulate excretion.

The convalescent treatment consists in regulated active and passive movements, with or without artificial aids, depending upon the degree of movement.

(Concluded in December issue).

DR. ARISTIDES AGRAMONTE.

Dr. Agramonte — whose name is known by all who have studied bacteriology or epidemiology — died recently of heart disease in New Orleans, at the age of 62 years. He was the last of the famous quartette who composed the Commission appointed by the U.S. Army in 1900 to investigate the yellow fever epidemics in Cuba. These four men — Read, Carroll, Agramonte and Lazear — will always remain among the heroic figures of medical research. To prove that yellow fever was transmitted by a mosquito, two of the Commission, with volunteers, remained in the ward of a hospital and in contact with the sputa, excreta and fomites from yellow fever patients. Carroll voluntarily allowed himself to be bitten by a mosquito which had fed on the patients dead from the disease, and his death was

accelerated, coming in a few years as a result of the very severe attack of the disease which he underwent. Lazear died as a result of accidental infection. Agramonte performed the autopsies, since as a Cuban he had previously been attacked by the disease.

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Book Reviews.

The Great Physician. Edith Gittings Reid. Oxford University Press, 1931.

We are all familiar with Dr. Harvey Cushing's excellent life of Sir William Osler, and possibly cannot see the necessity or desirability of another "Life" appearing within so short a time. But Edith Gittings Reid, we feel, has both created and filled such a need. For hers is a charming work, vivid and sympathetic and complete, even in its brevity, in giving us a comprehensive view of Osler, the "Great Physician" and the great man—which are truly synonymous terms—and in making clear to us the reasons for his successes, and for the vast multitude of deep friendships he seemed to draw to himself wherever he touched. The author has based her "Life" on Cushing's work, from which she quotes extensively; but she has had access, through an intimate friendship with the Osler family, to a store of

material hitherto unpublished. We can do no better here than quote from the author's preface her own apologia for the writing of a shorter "Life."

"But, above all, I am indebted to the 'Life' by Dr. Cushing, in which he has recorded, year by year, all the events of Sir William's life, and which leaves nothing to be desired by those who knew him personally. But there are those who did not know him who might be deterred by its length, and it has been thought desirable to publish a shorter 'Life.' If I succeed in bringing him for a moment before other eyes as I myself saw him, the reader will turn to Dr. Cushing's 'Life' and live from day to day with this Master and lover of men." And in talking of Sargent's famous painting, "But when he came to Dr. Osler, he was baffled for a while. Then suddenly he dashed a spirit on the canvas — and the group was vitalized. It is that spirit we are seeking in his life."

Mrs. Reid has caught something vital, and in her book has found this spirit. A.

Noguchi. G. Eckstein. Harper and Co., 1931.

The Noguchi biography forms an interesting contrast to that of Osler. Both were great men, both driving forces in the field of medicine, yet in their natures and in their work as widely removed as the poles. The difference is reflected in the manner of their biographers — the Osler work, serene, polished and expert in its workmanship; that of Noguchi, fiery, enthusiastic and sometimes almost crude in its construction. In both can be found a certain hero-worship — but how differently expressed. Eckstein tells his tale in short, staccato sentences and unfinished paragraphs, a style that sometimes tires a little, but, in the main, serves admirably to heighten the dra-

matic incident with which the book is packed. In this manner, he tries to bring home to us the illimitable energy of his hero, his unbounded enthusiasm, his genius, his ability to work for weeks almost without sleep, without rest, when the fire of accomplishment burned in his brain, his tremendous passion for research — and the measure of the author's success rests with the reader and his reaction to the author's mode of writing.

It is not as satisfying a book as Mrs. Reid's "Osler," but one finds oneself caught up and whirled along in its train of enthusiasm, following its succession of dramatic incident with an abounding eagerness — suffering with Noguchi in his discouragements, and jubilant with him in his triumphs. His story is the story of an indomitable spirit, a heroic figure, told by his chronicler in a very absorbing fashion. A.

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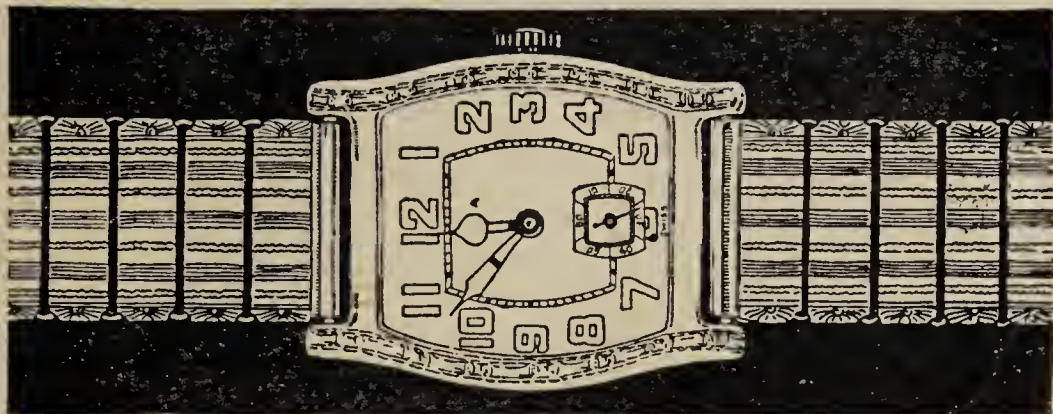
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